CLAIMS

1. A safety system for use with a machine having a moving part arranged to move through a known path of movement, the safety system characterised by comprising:

at least one light emitting means arranged to emit light, the axis of the emitted light being generally perpendicular to the path of movement of the part such that a region including at least a portion of said path is illuminated;

at least one light receiving means arranged to receive light from the or one or more of the light emitting means which has passed through said region; and

a processing and control means arranged to receive image information from the light receiving means and thereby recognise the presence of one or more shadowed regions on the light receiving means cast by obstructions in the region;

wherein the illumination of the region is such that the processing and control means has sufficient image information to determine the boundaries of the or each shadowed region and control movement of the part dependent on said image information.

2. A safety system in accordance with claim 1, characterised in that the processing and control means either slows or stops the movement of the part if the processing and control means determines the presence of an obstruction in a predetermined or calculated area of the region.

3. A safety system in accordance with claim 1 or 2, characterised in that the processing and control means calculates the positions of the obstructions relative to the part or relative to each other and slows or stops the part dependent on the relative positions.

4. A safety system in accordance with any one of claims 1 to 3, characterised in that the processing and control means calculates the speeds of movement of the

obstructions relative to the part or relative to each other and slows or stops the part dependent on the relative speeds.

5. A safety system in accordance with any one of claims 1 to 4, characterised in that the region is relatively large with respect to the size of a leading edge of the part and is entirely illuminated by a single parallel beam of light.

6. A safety system in accordance with any one of claims 1 to 4, characterised in that the region is relatively large with respect to the size of a leading edge of the part and is illuminated by an array of individual light beams.

7. A safety system in accordance with any one of the preceding claims, characterised in that the light receiving means is provided with a means to reject light rays that are not generally parallel to the axis of the emitted light.

8. A safety system in accordance with any one of claims 2 to 7, characterised in that an input means is provided such that when the processing and control means slows or stops the movement of the part, actuation of the input means by the operator informs the processing and control means that continued movement of the part is safe and the processing and control means resumes movement of the part.

9. A safety system in accordance with claim 8, characterised in that when the processing and control means is informed that continued movement is safe, the processing and control means stores in a memory means one or more maps made up of image information received by the light receiving means as the part moves through the path of movement.

10. A safety system in accordance with claim 9, characterised in that the processing and control means compares the current image received by the light receiving means

to the maps stored in the memory means and allows continued operation of the part if sufficiently similar.

11. A safety system in accordance with claim 9 or 10, characterised in that the processing and control means compares the current image map being created as the part moves through the path of movement to the maps stored in the memory means and allows continued operation of the part if sufficiently similar.

12. A safety system in accordance with any one of the preceding claims, characterised in that a part position detector is provided to detect the position of the part relative to the machine, the part position detector being arranged to provide information regarding the part position to the processing and control means.

13. A safety system in accordance with any one of the preceding claims, wherein the processing and control means is arranged to determine the vertical distance between a forward edge of the part and an obstruction casting a shadow on the light receiving means and allows continued movement of the part if the distance determined is greater than a predetermined distance required to safely stop the part.

14. A safety system in accordance with any one of the preceding claims, characterised in that the processing and control means is arranged to determine the thickness of an obstruction casting a shadow on the light receiving means and allow continued movement of the part should the thickness be less than a predetermined value, the predetermined value being a value determined to be small enough that the obstruction could not be a part of the operator's body.

15. A safety system in accordance with any one of the preceding claims, characterised in that the light receiving means utilises a relatively high shutter speed to give a strobe effect.

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16. A safety system in accordance with any one of the preceding claims, characterised in that the light emitting means is flashed to create strobescopic images of the obstruction.

17. A safety system in accordance with claim 15 or 16, characterised in that the processing and control means uses interpolation to determine the position of obstructions between samples.

18. A safety system in accordance with any one of claims 15 to 17, characterised in that the processing and control means uses interpolation to estimate the position of obstructions at some time in the future.

19. A safety system in accordance with any one of claims 15 to 18, characterised in that said flashing of the light emitting means is alternation between an on state in which the light emitting means emits light and a dim state in which the intensity of the light emitted by the light emitting means is reduced relative to the on state.

20. A safety system in accordance with any one of the preceding claims, characterised in that the light receiving means includes a charge coupled device.

21. A safety system in accordance with any one of the preceding claims, characterised in that the light receiving means comprises a projection screen and image information is detected by a camera arranged to observe the image on the projection screen.

22. A safety system in accordance with any one of the preceding claims, characterised in that the light receiving means and the light emitting means are mounted to be stationary relative to the part.

23. A safety system in accordance with any one of claims 1 to 21, characterised in that the light receiving means and the light emitting means are mounted stationary relative to the machine having the moving part.

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24. A safety system in accordance with any one of the preceding claims, characterised in that one or more shadow mask is provided and the processing and control means is arranged to recognise the shadow created by the shadow mask on the light receiving means and use this information to determine that the light receiving means is functioning correctly.

25. A safety system in accordance with claim 24, characterised in that the processing and control means is arranged to recognise the shadow created by the shadow mask on the light emitting means and use this information to determine if the safety system is in correct alignment.

26. A safety system in accordance with claim 24 or 25, characterised in that a first shadow mask is provided on the light emitting means and a second shadow mask is provided also on the light receiving means and the processing and control means is arranged to detect whether the first shadow mask of the light emitting means is in alignment with the second shadow mask of the light receiving means to determine if the safety system is in correct alignment.

27. A safety system in accordance with any one of the preceding claims, characterised in that a display device is provided to display the images received by the light receiving means.

28. A safety system in accordance with any one of the preceding claims, characterised in that the light emitting means includes one or mores lasers as a light source.

29. A safety system in accordance with any one of the preceding claims, characterised in that the light emitting means includes one or mores laser diodes as a light source.

30. A safety system in accordance with any one of the preceding claims, characterised in that the light emitting means includes a transmitting end lens arrangement including one or more transmitting end lenses such that light is directed by the transmitting end lens arrangement through the region.

31. A safety system in accordance with claim 30, characterised in that the transmitting end lens arrangement includes one or more concave lenses to expand the light beam.

32. A safety system in accordance with claim 30 or 31, characterised in that the transmitting end lens arrangement includes a transmitting end spherical ball to focus the light.

33. A safety system in accordance with any one of claims 30 to 32, characterised in that the light is focussed through a pinhole.

34. A safety system in accordance with any one of claims 30 to 33, characterised in that the transmitting end lens arrangement includes an aspheric lens arranged to columnate the light.

35. A safety system in accordance with any one of claims 30 to 33, characterised in that the transmitting end lens arrangement includes a means to correct for spherical aberration such that columnated light is directed through the region.

36. A safety system in accordance with any one of claims 1 to 31, characterised in that the light emitting means includes a transmitting end reflector and a relatively long focal length, the axis of the emitted light being transmitted generally perpendicular to an axis parallel to the forward edge of the tool onto the transmitting end reflector such that the light is reflected to pass through the region and the focal length being sufficiently long to remove the need to correct for spherical aberration.

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37. A safety system in accordance with any one of claims 1 to 34, characterised in that the light emitting means includes a transmitting end off-axis parabolic reflector, the axis of the emitted light being transmitted generally perpendicular to an axis parallel to the forward edge of the tool onto the transmitting end off-axis parabolic reflector such that the light is reflected to pass through the region.

38. A safety system in accordance with any one of the preceding claims, characterised in that the light receiving means includes a receiving end lens arrangement such that light passing through the region is focussed by the receiving end lens arrangement.

39. A safety system in accordance with claim 38, characterised in that the receiving end lens arrangement includes a means to correct for spherical aberration.

40. A safety system in accordance with claim 38 or 39, characterised in the focussed light from the receiving end lens arrangement passes through one or more pinholes.

41. A safety system in accordance with any one of claims 38 to 40, characterised in that the receiving end lens arrangement includes an aspheric lens.

42. A safety system in accordance with any one of the preceding claims, characterised in that the light receiving means includes a receiving end reflector, the receiving end reflector arranged to reflect light which has passed through the region to a direction generally perpendicular to an axis in a direction parallel to the forward edge of the tool.

43. A safety system in accordance with claim 42, characterised in that the reflector is an off-axis parabolic reflector.

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44. A safety system in accordance with any one of the preceding claims, characterised in that the machine is a press brake and the moving part is a tool of the press brake.

45. A safety system in accordance with any one of claims 1 to 43, characterised in that the machine is a press brake and the moving part is an anvil of the press brake.

46. A safety system in accordance with claim 44 or 45, characterised in that the tool is arranged to bend material and the processing and control means controls movement of the tool during bending.

47. A safety system in accordance with claim 46, characterised in that the movement of the tool during bending is slowed or stopped if the image received by the light receiving means is inconsistent with pre-stored or calculated images of material being bent in the same manner.